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Contract Number	NNX12CA21C
Title	Security-Enhanced Autonomous Network Management for Space Networking

Identification and Significance of Innovation: (Limit 200 words or 2,000 characters whichever is less)

The network management in the next-generation space networks faces the following challenging issues: 1) Integrated network management functions, which use common standards and implementations such as delay-tolerant network (DTN) services, are needed to serve the satellite customers; 2) Satellite operations currently use a highly manual approach. The research and development of autonomous operations has been conducted recently but is still at early stage; 3) Due to different characteristics of satellite networks, security management and other network management functions that are widely adopted in the traditional wired networks are not fully suitable to satellite networks. To address these issues, we developed a Security-Enhanced Autonomous Network Management (SEANM) system to enable automatic network management with intelligent analysis in space networking. Our approach allows the system to adaptively reconfigure its network elements based upon awareness of network conditions, policies, and mission requirements.

Technical Objectives and Work Plan: (Limit 200 words or 2,000 characters whichever is less)

The objective of this Phase II effort is to develop an autonomous networking and network management system for space networking through an efficient cross-layer negotiation approach. Towards this, specifically, we planned to work in the following aspects: 1) advanced bundle protocol – based DTN network support, 2) proactive network monitoring and prediction, 3) cross-layer information sharing and negotiation, 4) network analysis and reconfiguration, and 5) security schemes. With the key components resulting from the above aspects, our SEANM tool can provide an integrated solution that facilitates reliable and autonomous network management in space environments.

Technical Accomplishments: (Limit 200 words or 2,000 characters whichever is less)

In this effort, first, we performed literature studies on existing network management tools, with special attention paid to the networking and network management tools in DTN. Second, we conducted the design and development of the integrated cross-layer information sharing and negotiation. Third, we designed intelligent bundle-based routing algorithms for better support of DTN network. Fourth, we identified the list of network parameters for monitoring, performance analysis and reconfiguration. Fifth, we developed the network analysis scheme to assist the troubleshooting in DTN networks. In addition, we designed a robust security scheme against dynamic network topology and disrupted infrastructure service.

Although SEANM is generically applicable to any radio network, for validation it has been prototyped and evaluated on two specific networks, a commercial off-the-shelf hardware testbed using IEEE 802.11 WiFi devices, and a military radio testbed using JTRS AN/PRC-154 Rifleman Radio platforms. Through tests, it has been shown that our solution provides autonomous network management resulting in reliable communications in the delay/disruptive prone environments.

NASA Application(s): (Limit 100 words or 1,000 characters, whichever is less)

The developed network management solution has potential to largely reduce operation costs while maintain or even enhance the reliability for the NASA missions. Due to the heterogeneous nature of network assets and the lack of autonomy, the developed solution can be applied to the NASA's efforts on the integration of its current agency networks. The potential customers of our solution include robotic and human missions at locations ranging from the near Earth (e.g., EO-1) to deep space (e.g., Mars exploration). The developed solution or associated mechanisms can also be applied to the current/future DTN testbed such as DTN-Bone.

Non-NASA Commercial Application(s): (Limit 100 words or 1,000 characters, whichever is less)

The developed network management tool and its mechanisms can be applied to various military networks potentially supporting a number of major programs like Airborne Networks, and Joint Tactical Network Center (JTNC), etc. Integrated with software defined radio technologies, the developed tool can also be adopted in a wide range of military communication applications for enhanced networking capabilities for dismounted soldiers, e.g., JTRS AN/PRC-154 Rifleman Radio.

The commercial drive for reliable communication is also increasing. Potential commercial applications include satellite communications, wireless sensor/ad hoc networks, cognitive radio networks, and vehicle networks.